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FISHERY MANAGEMENT MEASURES INSTITUTED AT DISCOVERY BAY, JAMAICA, WITH SPECIAL REFERENCE TO ESTABLISHMENT OF THE FISHERIES RESERVE¹

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ABSTRACT Jamaican north coast coral reef fish stocks have been over-exploited. The Fisheries Improvement Programme (FIP) began in 1988 to help fishers at Discovery Bay to introduce management measures. Social and cultural constraints included poverty and distrust among fishers. FIP initiated: 1) an education programme in reef fisheries and the possibilities of local management; 2) encouragement of a Discovery Bay Fishermens' Association; in 1994, Association members agreed on a voluntary protected area within Discovery Bay; 3) a Reserve Planning Group, representing all users of the bay; 4) contract with Fishermens' Association: grant funds were transferred to it to employ rangers; 5) marking and daily patrols within the Reserve starting in 1996; and 6) legalization of the Reserve, which was not obtained. Within two years of Reserve protection, fishers perceived an increase in fish abundance and asked that the protected area be extended. Studies on fish populations in 1996–98, showed that the Reserve delayed age and size at recruitment to the fisheries and enhanced catches in adjacent waters. The failure to gain legal status and lack of funds to maintain patrols after 1999, led to decline in compliance with the voluntary restrictions on fishing. Lessons are discussed.

INTRODUCTION

The Jamaican fin-fishery is largely artisanal, carried out in open canoes (each containing 1–5 men), or by swimmers, using traps, hook-and-line, spears and gill-nets (Aiken 1993). Fishermen work on or near the shallow coastal shelves (Figure 1) and offshore banks, targeting fish in coral reefs and associated habitats. Stocks are over-exploited, especially near shore, and catch rates are very low (Munro 1983, Aiken 1993). Over-fishing is particularly severe along the north coast, where fishermen concentrate their effort on the narrow (< 1 km) coastal shelf. As a result of the intense local fishing pressure, Jamaican north coast coral reefs are among the most overfished reefs in the English-speaking Caribbean (Hughes 1994, Roberts 1995). Quality fish such as grouper and snapper are scarce, the catch of other species is dominated by small, young individuals, and the destruction of breeding stock has reduced the possibility of replenishment. A possible secondary effect of this intense level of overfishing is the effect on the reef habitat that supports the fishery. The absence of herbivorous fishes is believed to have been one of the factors facilitating a phase shift in reef composition from a coral to an algal dominated system (Hughes 1994). The infilling

of interstices with algal biomass (also promoted by the mass mortality of *Diadema*, Hughes et al. 1987) and associated reduction in complex three dimensional structure (on top of two hurricanes) could have an as yet undocumented effect on the ability of the reef to either sustain itself or act as a suitable habitat for various size classes and species of fishes.

Despite the poor state of the fishery, economic pressures, intensifying in the 1990's, continue to drive men into fishing (Allison 1992, van Barneveld et al. 1996). Some have no alternative, some do a little farming, while others are supplementing income from partial or full-time employment. Since nearshore fish stocks are so accessible, they can be exploited at low economic cost down to levels that give very low economic returns. For example, the average catch in fish traps at Discovery Bay in 1990 was 0.18 kg/trap/day (Picou-Gill et al. 1996). On the north coast, an average Jamaican fisher (including part-timers, crew and share fishers) makes less than \$7 per day over a 7-day week while supporting a family of five people (Sary 2001, all sums in US\$ at an exchange rate of J\$49). Most people have remained in the fishery either to supplement other incomes, or because they have no alternative. Fishing is given up or reduced when a person has better opportunities elsewhere, and resumed or intensified when times are bad. Multiple occupations are common in the Caribbean, and allow people to increase their economic security. Although the selling price of fish has risen in 2002, the average income from fishing, at least on the north coast, is less than other low income work available in Jamaica, where the legal minimum

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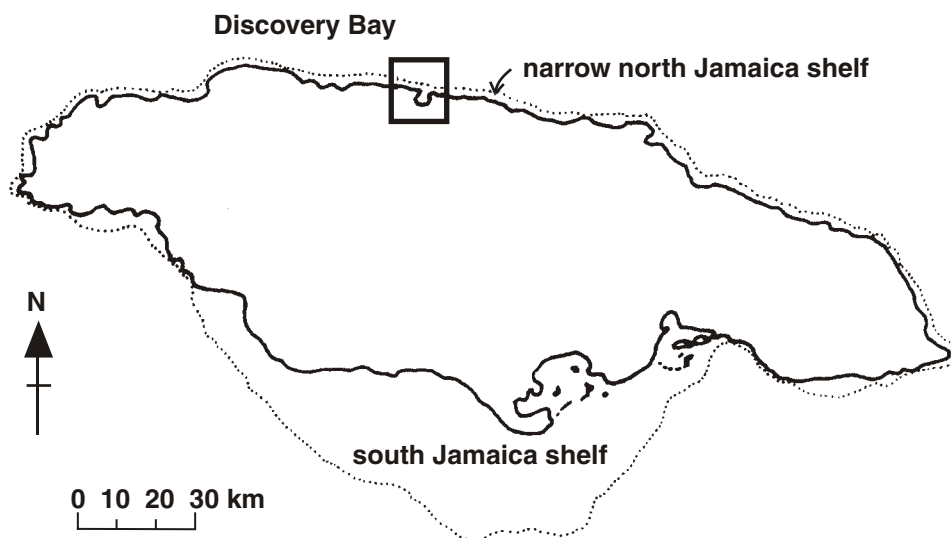


Figure 1. Map of Jamaica showing the 100-m depth contour and the location of Discovery Bay.

wage is \$11.22 per day for a 5-day week. Day laborers or hotel waiters can expect to earn \$16 to \$20 per day. However other jobs are scarce on the north coast and, in any case, many fishers prefer the independent life-style of fishing.

Improvement of the productivity of an over-exploited fishery depends upon reducing fishing effort. This is always difficult for fishers who are already making very little money. Moreover, in a coral reef fishery, only a few measures are practicable (Munro and Williams, 1985). These include the use of more selective gear, limited entry to the fishery, and protected areas. Marine Protected Areas (MPAs), specifically no-take reserves, are increasingly recommended for the enhancement of depleted coral reef fisheries (e.g., Bohnsack 1996). Such reserves are often created from the “top, down” and rarely from the “bottom, up”, but there are good Caribbean examples of the latter in St. Lucia (Jennings-Clark 1992, Roberts and Hawkins 1997). This paper, which complements that of Woodley and Sary (2003), describes the creation of a no-take marine reserve at Discovery Bay, Jamaica, by collaboration between a university-based facilitating agency and local fishers. The objective is to enhance local fisheries with a reserve planned from the bottom up, but to be operated within a co-management framework established by government.

METHODS AND BACKGROUND

Study area

Discovery Bay is in the middle of the north coast of Jamaica (Figure 1). The shallow-water marine environ-

ment, both outside and inside the bay (Figure 2), is dominated by coral reefs and associated habitats (Woodley and Robinson 1977, Gayle and Woodley 1998). The reefs are best developed on the submarine shelf outside the bay. The entrance to the bay has been excavated to make a 12 m deep shipping channel. In the middle of the bay there is deep water, with shallow sandy lagoons all around, supporting beds of turtle grass, scattered coral heads and patch reefs. On the steep slopes towards the centre, coral reefs occur down to about 20m, especially at Columbus Park and Red Buoy Reef. All reefs in the area were in good condition until hurricane Allen (1980), the first of a series of impacts (including coral disease, *Diadema* mass mortality, coral bleaching) that, superimposed on chronic over-fishing, led to a catastrophic decline (Hughes 1994). The town of Discovery Bay is at the south-east corner of the bay (Figure 2). At the south is Port Rhoades, the bauxite loading facility of the Kaiser Jamaica Bauxite Company. Other institutions include a small base for the Jamaica Defence Force Coastguard, a public beach, a small hotel, Columbus Park (which is a historical site for tourists) and the Discovery Bay Marine Laboratory of the University of the West Indies.

Discovery Bay fishing beaches

Fishermen operate from two fishing beaches (registered landing sites), which are quite distinct socially and economically (Figure 2). Old Folly fishing beach is adjacent to a residential area (and the bauxite loading pier), and is used almost exclusively by local resident fishers. It includes a fishing gear outlet and (a recent

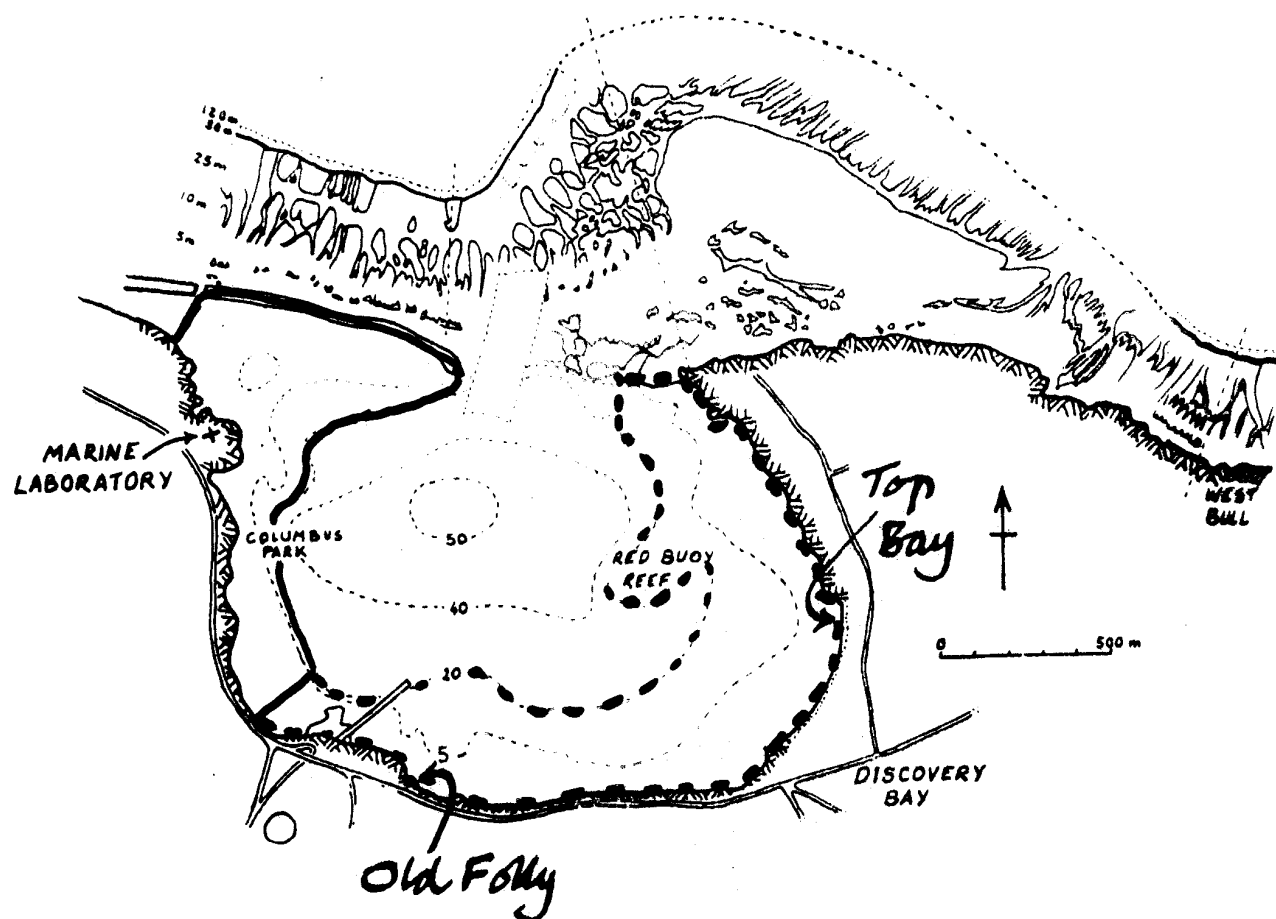


Figure 2. Map of Discovery Bay, showing the outlines of reefs on the offshore shelf and (within the bay) depth contours in meters. It also shows the locations of the Marine Laboratory, and the two fishing beaches at Old Folly and Top Bay. The boundary of the Discovery Bay Fisheries Reserve, as established in 1996, is indicated by a solid line and the extension proposed in 1999 by a dashed line.

addition) a bar, but little other activity (e.g., recreation) takes place on this beach. Top Beach is a much more active place. It is adjacent to high priced beach villas, as well as a growing squatter community, and it is used by a wide variety of people for fishing and recreation, many of whom are visitors from outside the community. There are a number of small shops on the beach, catering to fishers and visitors. The two fishing communities are even separated from each other geographically, by a large tract of rugged, undeveloped land in the middle of Discovery Bay. There is little communication or cooperation between the two fishing beaches, despite the formation of a fishing cooperative documented in this paper.

The principal target area for Discovery Bay fishers is the shelf outside the bay, which is roughly apportioned between the two beaches. After exiting the ship channel, men from Top Bay generally turn to the East, and those from Old Folly turn to the West (Allison 1992). The

distance that they travel to the East and West is determined by the logistics of travel and the possibility of interference with their gear, which increases with proximity to adjacent communities. Occasionally, fishers from other communities fish near Discovery Bay and, equally, Discovery Bay fishers may occasionally travel beyond their regular fishing area. Among those who fish within Discovery Bay itself are the young, the old, and other fishers in bad weather.

Fishing effort at Discovery Bay

About 50 active fishers use the two beaches, almost half of them relying on fishing as their sole income earning activity. Generally, each fisher supports another four people on their fishing income. Until the mid-1980s, women worked on the beaches as vendors, buying from the fishers (all men) as they returned. Since then, they have been displaced by consumers, who buy up the small catches directly. Over two-thirds of fishers own a boat.

The majority of these are small, usually unmotorized, wooden canoes about 15 ft (4.6 m) in length while the remaining third of the boats are the standard Jamaican 27-ft (8.3-m) reinforced fiberglass open canoes, all of which are powered by outboard engines (usually 35 to 65 hp). Many fishers use more than one gear type on each fishing trip. More than half use fishtraps as their primary or secondary gear, owning about 7 traps each. About 45% of fishers use hook and line, and 12% use nets. A tenth of the fishers are full or part time spear fishers, but many other spearfishers have not been enumerated, including a few who fish at night with lamps and SCUBA.

On average, about 6 fishing boats operate every day on the narrow fringing reef in or outside of Discovery Bay. About 4 of these boats are non-motorized. The 6 boats have a total, overall, of about 9 people operating from them (captain, share fishers, and crew). In addition, at least 4 spear fishers are fishing in the area. This represents over 2,100 boat trips per year, and over 1,500 spear fishing days per year. Trap fishing boats haul an average of 5 traps per fishing trip. Thus, during the estimated 1,400 trap fishing trips (or boat days) in the area during the year, nearly 7,500 trap hauls are made. Nearly 85% of the trap hauls are of 1.25-in (3.2-cm) mesh traps, and the rest are of 1.5-in (3.8-cm) mesh traps. About 600 boat days are spent hook and line fishing, most of them for drop line fishing; trolling may be done on the way to fishing grounds, but it is rarely the main purpose of a trip. Hook and line fishers target both shallow reef fish stocks and very deep snapper stocks. A small number of fishers use gill nets, setting their nets in shallow reef areas. The total catch of all fishing in the study area (about 6 km²) is about 14 tons per year, worth about \$68,500 (Sary 2001). Shared among the approximately 48 active fishers in the area, both full and part-time, it represents an average yearly income of less than \$1,500. The cost of entering and remaining in the fishery is high, except for spear fishing, primarily due to the capital needed to obtain and maintain a boat. Other costs of fishing depend on the method involved: high for trolling, moderately high for traps, less for nets and drop lines, least for spearfishing.

The facilitating agency

The obvious need for management led to the creation, at the Discovery Bay Marine Laboratory (DBML), of the Fisheries Improvement Programme (FIP, Sandeman and Woodley 1994, Woodley and Sary in press). Support from various agencies maintained the program, at levels of staffing ranging from 1 to 5, from 1988 to 2001. Its aims were 1) to assess the state of the

fishery, 2) to discuss the state of the fishery, and possible remediation, with local fishers, while increasing their awareness of the possibilities of coral reef management, 3) to help local fishers introduce fishery management measures, and then 4) to monitor the effects of these measures on fish stocks and catches. Most of the staff were university graduates in biology, while some of the education officers had more training in social sciences (anthropology and environmental education, development studies, agriculture). From 1995, interested people, some of them the children of fisherfolk, were recruited into the Programme from the local community and trained in fish identification and fishery management.

Development of participatory management

Some strategies pursued by FIP during its early days (1988–1993) were general preparation for participatory management; the specific focus on an MPA came later. FIP worked on other management issues, notably changes in trap mesh size (Sary et al. 1997), but they are not discussed here. An early survey revealed that MPAs were the least unpopular of proposed management measures (with about 30% support), since they would affect people using all gear types equally (Vatcher 1994).

Education

The primary contact of FIP staff with the fishing community was through collecting catch-and-effort data when boats returned to the fishing beaches in the mornings. Informal discussion of fishery-related matters was carried out when staff interacted socially with fishers (e.g., while waiting at the beaches for boats that were still at sea). A more formal program of environmental and fishery education was the specific task of designated Education Officers, employed when funds were available. Its initial aims were to increase fishers' knowledge of the fishery resources, to encourage a sustainable approach to fishery management and to promote changes in fishing behavior expected to result in long-term improvement of fish stocks and catches (Van Barneveld et al. 1996). A varied approach was necessary since fishermen differed in educational level, fished at diverse times and places, and did not meet as a group. Their knowledge, fishing practices and attitudes to fishery management were assessed by an initial questionnaire (Vatcher 1994), and later re-assessed. At both fishing beaches, FIP staff erected notice boards, which were used to display material of local and general interest. These included educational posters, articles from the press, notices from the Fisheries Division of the Ministry of Agriculture, and notices of local meetings. FIP also showed slides and

videos, and encouraged visiting scientists to address the fishers about their own work. Increasing numbers of educational videos became available, describing marine ecology and fishery management in other countries, which were well received by fishers. For a while, “video nights” were frequent, combining educational features with more conventional entertainment. In 1991, the Education Officer Wendy Lee (then Van Barneveld) made a video, with the participation of the Discovery Bay fishing community, entitled “Fish today, Fish tomorrow? Tradition and change in a Jamaican Fishing Community”. In 1998, another video was made about the work of FIP, sponsored by the CARICOM Fisheries Research and Management Program (CFRAMP), entitled “Fishing for a brighter future”. In 1997–1999, when the Fisheries Reserve was operational, a newsletter, “Fishlinks”, was prepared and distributed to fishers, householders on the Bay, and elsewhere in the community.

Alternatives for fishermen

As part of the move to reduce reef fishing effort and to explore other sources of income for the fishers, some possible alternative occupations were explored. First was Irish Moss (*Gracilaria*) culture, as developed by the Caribbean Natural Resources Institute (CANARI) in St. Lucia. Male and female members of the fishing community were taken to demonstrations organized in Jamaica by Dr. Alan Smith in 1991, and attended courses in St. Lucia (1993, 1996). Meanwhile, FIP staff cultured the alga on rafts, following the lead of Macfarlane (1991). In 1995, Dr. R.D. Steele (Department of Life Sciences, University of the West Indies) began research on floating cage culture of red hybrid *Tilapia* at Discovery Bay with the aim of making the method available to local fishers. In 2002, DBML began to help local men fish offshore with troll-lines, deep drifting lines, and deep traps.

Encouragement of fishers’ organizations

FIP believed that the needs of individual fishers would be more effectively articulated by a group organization. In particular, it was felt that a cooperative society might help to develop a community-based approach to fishery problems (Van Barneveld et al. 1996). While wanting to encourage the formation of such a group, we recognized that fishers had been discouraged by the failure of at least two previous attempts to form a fishers’ organization at Discovery Bay: one because the treasurer absconded with its money, the other because it had been set up by a well-meaning outsider without any commitment from its members. We took some fishers to meetings

of apparently successful fishing cooperatives on the south coast and to other fishing-related events. In 1991, some fishers from Old Folly asked for assistance from FIP in establishing a cooperative society. This was no easy task, partly because it was the policy of the Co-operative Department to support larger groups rather than small ones, which were deemed unviable. So the new body became the Allover Discovery Bay Fishermens’ Association (ADBFA), named after the property on which the fishing beach was located.

Formation of the Reserve Planning Group

In 1995, after a Reserve had been proposed (see Results), a Reserve Planning Group (RPG) was formed, and began to meet monthly. Its members were drawn from organizations with an interest in the waters of Discovery Bay, namely: ADBFA; Top Bay fishing beach; Jamaica Defence Force Coastguard; Kaiser Jamaica Bauxite Company; and DBML. Two members of FIP acted as Chair and Recording Secretary. ADBFA was represented by four members and the other organizations by one each.

Contract with Fishermens’ Association

Operation costs for the Reserve, chiefly to hire rangers, had been included in a grant from the Kaiser Jamaica Bauxite Company to the University of the West Indies (UWI) for FIP. This money and the responsibility to hire staff were transferred to the Fishermens’ Association. In 1996, UWI and the ADBFA entered into a contract under which the Association agreed to operate the Reserve, subject to the guidance of the RPG. The Association would employ rangers to patrol the area, in exchange for monthly transfer of funds from UWI, while FIP would certify that the work was done and the money properly accounted for.

Marking of the Reserve, and daily patrols

The ADBFA selected four rangers and a supervisor, who were themselves fishermen or relatives of fishermen. They were trained by the JDF Coastguard and by rangers from the Montego Bay Marine Park. DBML provided large (2-ft (0.62-m) diameter) red buoys, and the new rangers helped to install them around the seaward margins of the Reserve (Figure 2) in 20 m and 10 m depth. Grant funds were used to purchase a dedicated patrol boat: a small whaler, not suitable for offshore fishing, with the name PATROL painted in bright red letters on its sides. In 1996, daily patrols began, concentrating on early morning hours, when fishermen are generally most active. Since the Reserve was only volun-

tary, and not yet legal, the role of the rangers was advisory and educational.

Legalization of the Reserve

FIP sought to establish the Reserve as a protected area under the Natural Resources Conservation Act (1991) in 1997. A comprehensive management plan was required, as for a multi-use park, which FIP staff (then reduced) found difficult to compile. Discussion with members of the Fisheries Division in 1999 established that it would be more appropriate, and quicker, to have the Reserve gazetted as a Fish Sanctuary under the Fishing Industry Act of 1975. A simple explanatory document, including a brief management plan with precise co-ordinates of the proposed protected area, was requested and was prepared in 2000.

Research on the fishery

The effectiveness of the Reserve was studied from 1996 to 1999 by an International Center for Living Aquatic Resources Management (ICLARM) project (Munro 1999). One-inch (2.5-cm) mesh traps were used to monitor the size and abundance of reef-fish within the Reserve. In addition, nearly 7,000 fish were caught, marked and released there. Recaptures were sought by continued trapping in the Reserve and from fishers operating elsewhere (Munro 2000). A UWI graduate student has been monitoring reef fish size and abundance by visual census but the work is not yet finished (K. Black-Clarke, personal communication, Centre for Marine Sciences, University of the West Indies, Kingston 7, Jamaica).

RESULTS

The preliminary assessment of local fish stocks confirmed that they were over-exploited (Miller et al. 1996, Picou-Gill et al. 1996). FIP continued to collect fishery data, while focusing on the development and assessment of participatory management.

Development of participatory management

Among Jamaican fishers, there are social and cultural constraints on the development of participatory management. Jamaica, like most of the English-speaking Caribbean, has an open-access fishery. Fishers believe that all people have a right to fish in the sea, as long as they do not infringe on the right of others to fish as well. The sea and fishing is viewed as a refuge where a person can go and find food when down and out until he is able to support himself again with other resources or other work. Thus, the sea is significant for many people who do

not actually fish, just as family land is significant for the many family members who do not actually live on it. This significance is greater than the sheer economic reward that may come from fishing, which may be only modest. It is an important token of security available to all people. These cultural beliefs and values color fishers' perceptions and practices concerning marine resources. The fact that the fishery is, and is seen to be, free to all, means that there is a general, though variable, resistance to the closure of coastal areas to fishing, such as in the Discovery Bay Fishery Reserve.

Fishers are not a homogeneous group; there are a number of ways fishers differentiate among themselves, a differentiation that affects their attitudes to the Reserve. These differences include the type of fishing gear used, the fishing beach they use, the degree to which fishing is a full-time or part-time occupation, and the perceived wealth of individual fishers.

The difference in type of fishing used has important implications. For example, the effect that the Reserve has on a fisher varies according to the fishing method he uses. Also, fishers tend to be suspicious of those who use other fishing gears. Trap fishers are especially suspicious of spear fishers, as the latter have been known to steal fish from traps. Trap fishers regard this issue extremely seriously. Because of the concern over theft from traps, most fishers who do not themselves use spear guns advocate a ban on spear fishing. Spearfishers respond that fishing with small mesh traps over many decades is the cause of fish stock decline, not spear fishing. There is little constructive dialogue between the groups. Trap fishers also fear theft by other boat operators, and may leave their traps unmarked, despite setting them relatively deep.

Fishers make social distinctions based on geography as well, according to the fishing beach that they use. Fishers from Old Folly tend to regard their Top Beach colleagues as rebellious and uncooperative; while Top Beach fishers seem to have little interest in the activities of the Old Folly community, or in the operation of the fishers' cooperative which is located there. When traps are interfered with, men usually suspect fishers from another beach, or another town.

Although north coast fishers are generally considered to be poor, fishers make economic and social distinctions within the group. Those seen as the richest fishers own their own fiberglass boats, and may have good paying jobs, or have lived overseas for a number of years. These distinctions of wealth and class seem to be very significant among fishers.

The various distinctions fishers make among themselves reduce the potential for cooperation among them. This lack of cooperation, with its associated fragmentation, has important consequences for the operation of a Reserve. There is little collective involvement by fishers because crucial elements of social life necessary for that involvement are missing or poorly developed, namely a strong sense of community and community groups willing and able to take on specific responsibilities (White et al. 1994).

Fragmentation and suspicion among fishers make it very difficult to pass information to the fishing community. Men who attend meetings do not generally relay what they have learned to the other fishers. Moreover, because many fishers cannot read, they will not understand messages on notice-boards, unless colleagues read to them.

There is also little willingness among fishers to make individual sacrifices, such as giving up a particular gear or fishing area for the common good: the sort of sacrifice that a marine protection regime requires. This is hardly surprising, given the low income levels and the economic vulnerability of most fishers. Sacrifice is more likely to be made if fishers perceive a real and immediate personal benefit or, alternatively, if there is some guarantee that others will do the same. This resistance is not absolute, however, and is perhaps more prevalent among the younger men, but all fishers believe that those whose livelihoods are adversely affected by fishing restrictions deserve compensation.

Despite these unpromising social attitudes, there is no doubt that, on the whole, the strategies used for creation and operation of the Reserve worked. What worked and what didn't are described in the following paragraphs.

Education

The education program was most effective when conducted by a dedicated staff member with some relevant training. Other staff could contribute, especially during informal interactions with individuals or small groups, but had to learn some basic rules. First was to show respect to the beliefs and views of fishers, however strange they might seem to be. Education is a two-way process and despite cultural differences, we can all learn from others. Second was not to be too quick to advance one's own recommendations, and not to tell people what they should be doing (unless asked). It was hard not to become promoters of management actions, and staff had to recognize that their role was mainly to provide information to the fishers, so that they could make their own decisions. In particular, we told them what coral reef

fishers were doing in other parts of the world, and explained why some of these activities were effective. With respect to no-take reserves and other protected areas, material from the Philippines and St Lucia was particularly useful.

Some of the FIP staff were good at interaction with resource users and others were less so, irrespective of their training. Personal qualities of empathy, social understanding and sociability were important. Video presentations were popular and reached a wide cross-section of the community. The availability of equipment was crucial: not only VCR and monitor but, for use near the fishing beaches, long extension cords and sometimes a portable generator.

Alternatives for fishermen

Although FIP maintained Irish moss cultures for years, and processed a small amount as a demonstration project, there was little interest among fishermen. The few individuals who followed up their interest were women. The experiments on cage culture of *Tilapia* worked out how to deal with parasites and other practical problems (Loy Malcolm, *Tilapia* mariculture, biological, environmental and economic feasibility, M. Phil. thesis in preparation, University of the West Indies, Kingston 7, Jamaica), but have not yet addressed transfer of the technology to the fishers. One Discovery Bay fisherman stole their thunder by culturing large quantities of *Tilapia* in a small natural sink-hole. The offshore fishing program received an early setback when the first set of deep traps was lifted by persons unknown. FIP members helped some fishers, interested in diving, to find jobs in water-sports.

Encouragement of fishers' organizations

The Fishermen's Association played a crucial role in bringing fishermen together and facilitating collaborative action at Discovery Bay. Its members built a meeting hall at Old Folly beach. Also, with a little help from FIP, it secured two grants: one to build a gear-store and offices, the other to supply large-mesh wire for traps. Their retail gear store now serves many fishers from the north coast, and the ADBFA became a district branch of the Jamaica Co-operative Union. In 1999, it became the Discovery Bay Fishermen's Cooperative, eight years after the idea was first suggested. Nonetheless, inter-group rivalry is still evident. The ADBFA was established by men from the Old Folly beach, and although membership is open to all, few members are from Top Bay beach. Most members are trap- or line fishers, rather than spearfishers.

Although not every fisherman respected its authority, the ADBFA institutionalized the processes of meeting, and making decisions. After many discussions about possible fish sanctuaries, a meeting of the ADBFA in 1994 decided to “give it a try”. The area selected, to be known as the Discovery Bay Fisheries Reserve (DBFR), was in shallow water on the west side of the Bay and covered 27.5 ha (Figure 3). Not much fishing went on there, but the men were unanimous that the Reserve should not include any of the fore-reef, which is the more productive area.

Formation of the Reserve Planning Group

The RPG has been an effective group, planning the creation and operation of the Reserve, which was to be established by voluntary action of the fishermen before legal protection was sought. The RPG discussed public relations, details of the Reserve boundaries, how they were to be marked, and how restrictions on fishing were to be enforced. Its decisions were reached by consensus, and included adjustment of the boundaries along one section, from 20 m to 10 m, to provide fishermen with an alternative fishing area for use during bad weather. FIP and the ADBFA were represented at every meeting, but attendance from the other entities was irregular. Moreover, although attempts were made to secure representation from the owners of homes on the eastern shore of the Bay (mostly business people based in Kingston), and from the small hotel on the southern shore, no one came.

Contract with Fishermens' Association

This arrangement worked well, although funds were sometimes late in arriving from Kingston. The ADBFA committee appreciated the 10% overhead paid to the Association for administrative expenses, while UWI appreciated not having to be involved with the temporary employment of staff at long range. When staff performance was unsatisfactory, replacements were quickly hired. Local management was not only more efficient, but it increased the sense of stewardship among fishers.

Marking of the Reserve, and daily patrols

It had been proposed that fisher members of the RPG would be present when the marker buoys were installed, but this did not always happen. In consequence, there was some dispute as to whether the markers had been placed at the correct depth. The large marker buoys were effective advertisement of the Reserve: smaller ones were sometimes stolen. However, large buoys are expensive, and DBML did not put out enough of them.

The rangers and their supervisor, never less than two in the patrol boat, carried out their advisory role in a non-threatening way, but pointing out that legal protection would soon be obtained. Most trap fishermen respected the local restrictions. The spearfishers, mostly boys, often did not, although they would say that they were only passing through on the way to the fore-reef. The RPG wanted the rangers to be on patrol at first light, when fishing began, but they were usually late. Also, they probably did not spend enough time in the Reserve, after their initial patrols.

Daily patrols continued into 1998, with occasional interruptions, until their frequency was reduced due to shortage of funds. Meanwhile, fishermen noticed that fish numbers had increased within the Reserve, and trap fishers began to concentrate immediately outside its outer boundaries. Moreover, fishers based at Top Bay beach, having seen the benefits of the Reserve on the western side, asked that it be extended all around the Bay. The new boundary details were resolved by discussion among Top Bay fishers, and were accepted by the RPG. The extended Reserve (Figure 2) covered 108 ha.

Reduced patrols were continued into August 1999, when the last of the rangers were laid off. Patrols were to have been continued on a voluntary basis by the ADBFA and FIP but, for various reasons, only one such patrol was made. In any case, because the Reserve had no legal status, continued protection was hard to maintain. It was threatened by the activities of new fishers, some from outside Discovery Bay, and by other recalcitrant individuals unwilling to comply with voluntary restrictions. By 2000, in the absence of both legal status and active patrolling, even some individuals previously compliant with the restrictions (including two former rangers) were ignoring them.

Legalization of the Reserve

The proposal to establish the DBFR as a fish sanctuary was sent to the Fisheries Division early in 2000. Unfortunately, Division staff were then involved in extensive litigation concerning the conch fishing industry and, up to April 2001, had no time for other work. In 2001, although the Fisheries Division was ready to proceed with formalizing the Reserve's status as a Fish Sanctuary, some uncertainty had arisen in the Reserve Planning Group about the acceptability of the new boundaries. Although individual members of the RPG were sent an update on the situation (including a draft of this paper) in December 2001, the Group has not met since 2000.

Research on the fishery

Studies on fish populations within the Reserve, from 1996–1998, showed that protection in the Reserve delayed age and size at recruitment to the fishery and therefore enhanced catches in adjacent waters. It was shown to supply some fish (mostly *Sparisoma* spp.) to reefs offshore for several kilometers to the east and west. Species taking up residence in the Reserve had the potential to supplement depleted spawning stock biomasses (Munro 1999, 2000).

DISCUSSION

Development of participatory management

The joint work of the Fisheries Improvement Programme and the fishers of Discovery Bay towards establishing a protected area has had many successes. The most difficult step was the first: for fishers to agree not to fish in even a small area, and it was preceded by years of discussion. It takes a long time for fishers to change their fishing behavior in response to external advice (Russ and Alcala 1999), an important point for funding agencies to consider! What made it easier was that western Discovery Bay was not a very popular area with trap fishers, and those who did fish there, except for a few old men, also fished outside. Then, after protection of this area was seen by fishermen to increase the biomass of fish populations, expansion of the reserve was proposed. During 1998–1999, the Reserve was at a peak of effectiveness. Its subsequent decline was due to lack of funds to continue education by patrolling, and the unexpected delay in obtaining legal backing; an event beyond our control. The educational work of the Fisheries Improvement Programme (or any other facilitating organization) is not just about fishery science, but is facilitating local social and economic development. Progress in development often follows an irregular rather than a linear trajectory, and we believe that our strategies, further discussed below, amount to an investment that will yet be rewarded.

It was necessary for all participants in the development process to be in continual communication. This was not always easy, because key individuals were distributed between different parts of Discovery Bay and Kingston, 140 km away. The fact that participants moved in different walks of life and social classes did not help. Secondly, but not unrelated, it was essential to build and maintain trust between individuals and thus between the institutions they represented (Kelleher 2003). Unfortunately, communication and the planning processes have often been disrupted through the departure of FIP staff,

either through lack of funding or as expatriates returning home. It has been described as a “revolving door” at DBML for people who take up fishery issues for a while and then leave: not good for a developmental process that may take many years.

Education

A sustained education program was of over-riding importance to the initiation and maintenance of community action. It took many forms, and many lessons were learned, particularly about social interactions between the participants in the management process. Most FIP staff were biologists and had some training in fishery management. Nonetheless, it had not adequately prepared them for the tasks of facilitating community action. First, it gave no training in how to work with people. Accustomed to pedagogic teaching, they expected fishermen to readily understand the potential benefits and to want to implement management at once. They did not realize, when this work began, that for adults to absorb new ideas and change their customary behavior may be a slow process, especially if it requires community action. Secondly, their training encouraged them to believe that they knew what was best for the fishery. It was then difficult not to take an authoritarian approach. Thirdly, because they thought they knew best, they were slow to appreciate that community education is a two-way process. Biologists could learn from the fishers, both about the natural history of fish and other creatures, and about the social and cultural contexts within which fishing was conducted. Some of these communication errors could have been avoided had the scientists developed more quickly a frame of mind that accepted the fishers as equal co-workers in the process of managing the fishery. Conventional surveys of “knowledge, attitudes and practices” do not always help since they tend to define fishers’ experiential and cultural knowledge in terms of “higher” scientific knowledge. Their knowledge is not necessarily wrong, just different. Finally, fishery training caused potential managers to focus on what was thought best for the overall fishery in the long term, and they were not always sensitive to the immediate hardship of the fishers. A reduction in fishing effort generates short-term costs which are usually borne by the fishers. It can be very helpful if management proposals include some compensation (as in the case of the “two-for-one” mesh exchange; Sary et al. 1997), some alternative activity, or can be phased in slowly.

The interaction with fishers in the course of data collection was itself part of the mutual education process. While FIP staff were gathering useful data, they were

developing familiarity with fish species and with the fishers. It was an opportunity to raise interest in fishery data and its value, while staff earned some respect through willingness to get their hands dirty, and demonstration of some knowledge of fishes. There were some negative aspects to the data collection process. First, fears that the information would be given to the tax authorities had to be allayed. More significant, it wasted fishermen's time when customers were clamoring for fish; and not all men wanted to collaborate. Alternative strategies should be considered, in which data are collected at sea. Most important, not just for education but to show integrity and reliability, scientists must remember to share with fishers the results of data collection. Meanwhile, if the education programs can be continued, more impetus for conservation might develop within the Discovery Bay community.

Alternatives for fishermen

Ideally, a *Gracilaria* culture area would be shallow, sheltered from rough seas, and not much used by others. Discovery Bay is too populous for cultures to be secure from theft, and the adjacent coastline is too rough. It is possible that any form of mariculture, which resembles farming more than fishing, and carries continuous responsibilities for maintenance, would be perceived by fishers as imposing a less attractive lifestyle and one that, for a fit young man, would probably be less rewarding financially than spear or net fishing. In addition the algae, despite their reputation as an aphrodisiac, may be perceived as a less manly product. Perhaps the future for local algal mariculture lies with the women. Work is continuing on *Tilapia* culture and on exploratory off-shore fishing.

Encouragement of fishers' organizations

The manner in which the Fishermen's Association (ADBFA) was formed well illustrates the point about not telling others what to do. Despite their recent contrary experience, including the failed external imposition, fishers who were exposed to functioning fishers' organizations made their own decisions, and asked FIP to help, not the other way round. Subsequently, the fact that the ADBFA was able to attract outside funding was powerful evidence to fishers of the benefits of an organized group. However, the flow of grant money into the ADBFA had some negative effects. Because the funds were managed by a small group, suspicions and further divisions arose. This points to a need for more transparency, and for the involvement of diverse people in any working group.

Formation of the Reserve Planning Group

When fishers from the different beaches were brought together in the RPG, discussing management measures with a wider group, their rivalry was apparent. It is not yet much diminished, but this exposure is a first step towards reducing the differences. In the future, the Group must ensure that all users of the bay are represented. This should include the home-owners from the eastern shore, Portside Villas (the small hotel), and the public beach, Puerto Seco. In addition, a representative of the Fisheries Division should be invited; under the new Fisheries Act, it is required to chair all such local management committees. Had the RPG kept in closer touch with the Division, the hiatus of 2000/2001 might have been avoided.

Contract with Fishermen's Association

If funds become available again for operation of the Reserve, similar arrangements are recommended.

Marking of the Reserve, and daily patrols

Although the few large red buoys gave a general impression of the Reserve location, more numerous and slightly smaller, but labeled markers would be preferable. Some dispute over the boundaries could have been avoided had fishers always been present when the boundaries were marked. The patrols could have been more efficient, but they were effective. Some fishermen learned that the Reserve was having a positive effect and adopted the practice of fishing close to its boundaries, as has been reported from Kenya (McClanahan and Mangi, 2000) and Florida (McLellan and Tobias 2002). Moreover, fishers from Top Bay had sufficient confidence in the Reserve to request its extension. Unfortunately, the perception of more fish in the reserve creates more incentive to poach, making enforcement more difficult.

Legalization of the Reserve

All participants have learned that community action is not enough; legal status for the Reserve is essential. Legal protection for the Reserve would make it much easier for members of the ADBFA, and other concerned citizens, to apply the restrictions on fishing. Moreover, the local Coastguard forces could participate in enforcement; at present, they are powerless. This would be a new situation, and users of the Bay should be allowed a period of education. Moreover, since there is a fear that military personnel might use inappropriately robust methods, they too would benefit from some special training. The RPG should plan a graded suite of responses for enforcement, with legal action a rare last resort.

Outlook for the future: will the DBFR ever succeed?

The general question “will it succeed” includes (a) will it gain legal existence; (b) will it benefit the people of Discovery Bay; and (c) can it be sustained? In the future, other questions would arise: e.g., will the fishers want to expand the protected area, perhaps onto the fore reef, and will adjacent communities want to adopt the concept?

(a) The Fisheries Division is now ready and willing to move ahead with legalization of the Reserve, as soon as the Reserve Planning Group gives the go-ahead. A meeting of that Group should be convened to review the proposed plan and, after agreement, to re-submit it. Legal declaration of the Protected Area could follow within months.

(b) According to preliminary work by Munro (1999), the Reserve would benefit fish, fishers and the economy. We do not yet know the full extent of those benefits and whether they will outweigh the costs; these, too, are unknown. It is true that only a few trap-fishers and migrant spearfishers will be displaced and running costs could be low, but those calculations should be made as soon as costs and benefits can be quantified. Its value as a focus of local pride and conservation education should not be forgotten. If it is concluded that the Reserve costs more than it is worth, then it could be modified or discontinued.

An increase in the size and abundance of fish within the Reserve would also benefit shore-based recreational line-fishers (permitted in the proposed regulations) and snorkelers, including local residents and a few tourists. It would certainly be of interest to some scientists and students from DBML, particularly if an increase in abundance of herbivorous fishes had any positive effects on the benthic reef community. However, the great majority of DBML scientists work on the fore-reef, where it is likely that continuing high fishing pressure would prevent there being much noticeable change in fish populations.

A group that would bear some initial cost are the spearfishers who fish in the Bay. Most of these, however, are on their way to or from the fore-reef (except in bad weather) where the catches are better and might be improved by the Reserve. Nonetheless, when stocks improve within the Reserve, spearfishers will be tempted to hunt there, presenting a problem for enforcement. This problem of poaching is also an opportunity to encourage the development of a culture of community responsibility for, and management of, the resource. If it benefits all then it is in their best interests to put some of their differences aside and invest time and effort in

securing it against outsiders or against residents who would exploit it to the detriment of other locals willing to make a short term sacrifice for the long term good.

(c) Would the Reserve be sustainable? It was maintained fairly well for three years by advisory patrols who established a degree of voluntary compliance among local fishers. However, it was becoming more difficult when the legal status that had been promised did not materialize. Moreover, the patrols cost about US\$15,000 per year, and funding at that level is unlikely to be available. If the Coastguard were able to patrol the Reserve without charge, it would be a huge advantage. Such funds as were obtained could then be used for education and logistic matters.

Education should remain a high priority, to help develop community support for the Reserve. Such support was beginning to develop spontaneously in 1998-99, as the benefits of protection were perceived. If that level of protection is achieved again, the increasing numbers of “believers” might reach a critical mass, after which growth would be self-sustaining. It is good that environmental education is now included in Jamaican primary and secondary school curricula. The development of local pride and peer pressure would be the best guarantee of sustainability.

A continuing education program could be run from the DBML, as have others, on and off, for the last 20 years. This has some drawbacks. Fishers may reasonably suspect that DBML has something to gain from a Reserve, perhaps more than the fishers have. This may be reinforced by the perception that Lab staff, sometimes expatriate, gain jobs and degrees while working with the fishers, who seem to gain little from their work. That is partly a consequence of FIP’s failure to adequately inform fishers about the results of their research; notably the apparent benefits of the mesh exchange (Sary et al. 1997, Sary et al. 2001) and the Fisheries Reserve (Munro 1999, 2000).

Operation of the Reserve would be driven by a Management Committee representing all stakeholders, which would be a formal upgrade of the existing Reserve Planning Group. It would still be necessary, at first, for DBML to assist with the material and logistic operation of the Reserve. While the allocation of a contract for patrolling the Reserve to the Alloo Discovery Bay Fishermens’ Association undoubtedly focused their minds and effort on the tasks, doubts remain about the ability of local organizations to operate long-term social programs. Some people despair about contemporary Jamaican society and prevalent negative attitudes, especially in the young, towards anything that requires

discipline, sacrifice and perseverance. Perhaps, as in other “Western” societies, this is partly a consequence of the capitalist promotion of individuality and competition. For a community group to function well, one needs a culture of cooperation, trust, avenues for dialogue, respect for democratic decision-making, and the ability to gather and use available information. With reference to Jamaican society, Espeut (2001) made the point that “discipline does not just happen, it has to be managed - like development. Where the infrastructure for discipline is in place - including the right values - people often develop orderly habits and a culture of discipline that makes for easy social interaction”. If it is not in place, community education is an uphill task, and the establishment of community-run protected areas will take many years.

In any case, it is now widely recognized that it takes a long time for communities to change their ways, and the creation of Marine Protected Areas is no exception. FIP’s work in Discovery Bay, like its funding, has been intermittent, with frequent shortages of staff, and this has slowed its progress. In any case, local action alone is not enough: neither top-down nor bottom-up approaches to management can work in isolation. Best is some form of co-management, in which Government provides a framework of education, legislation and enforcement that is supportive of community participation in environmental management. Senior staff of the Centre for Marine Sciences, University of the West Indies, are determined to continue trying to help the citizens of Discovery Bay and the Fisheries Division to promote fish conservation and fishery development.

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